CHAPTER 8

COSTS OF PRODUCTION

Chapter in a Nutshell

This chapter gives an in-depth look at the costs of production for firms, both in the short run and in the long run. Although production techniques may differ from one industry to another, and even among firms operating in the same industry, there are features of production costs that are common to all firms. When an entrepreneur makes a decision to start a business, this commitment usually involves total fixed costs for items such as mortgage payments and insurance. Total fixed costs do not vary with the level of output. Even if the firm produces nothing at all, total fixed costs exist. When output is produced, the firm incurs total variable costs that correspond to payments made for resources such as labor and materials. The sum of total fixed costs and total variable costs is equal to total costs. Total fixed costs, total variable costs, and total costs can be graphed to show the three total cost curves.

From these three total cost curves, we can derive four other cost curves. Average total cost is found by dividing total costs by output. Similarly, average variable cost is total variable costs divided by output, and average fixed cost is total fixed costs divided by output. Marginal cost is the change in total costs that occurs when one more unit of output is produced. We will examine the usual shapes of all of these curves, as well as the special relationships among them.

Labor is often the most important of the variable cost items, and its importance is reflected in the shape of the total variable cost curve. Labor costs tend to increase at a decreasing rate when output is low, but as output increases, labor costs eventually rise at an increasing rate. The character of the total variable cost curve reflects labor costs by rising at a decreasing rate at low levels of output and at an increasing rate as output increases. The portion of the total variable cost curve that rises at an increasing rate exhibits the law of diminishing returns. In the short run, some resources used in production are fixed, while it is possible to vary the amount of labor employed. Adding more labor to production when these resources are fixed will increase total product, but by smaller and smaller amounts.

The firm’s long-run average total cost curve shows the envelope curve formed by drawing a line tangent to the firm’s short-run average total cost curves. The long-run average total cost curve shows the firm in its long-run position when it is able to change the quantity of all the resources used in production. When the long-run average total cost curve is decreasing, there are economies of scale; when it is a horizontal line, there are constant returns to scale; and when it is increasing, there are diseconomies of scale.

The characteristic shapes of the cost curves that are presented in this chapter are supported by ample empirical evidence.

After studying this chapter, you should be able to:

- Describe how someone becomes an entrepreneur.
- Explain short-run commitments to fixed costs.
- Distinguish between total fixed costs and total variable costs.
- Construct an example to show the law of diminishing returns.
- List and explain the determinants of labor costs.
- Draw curves to show total costs, average total costs, average variable costs, and marginal costs.
- Contrast economies of scale, constant returns to scale, and diseconomies of scale.
Concept Check — See how you do on these multiple-choice questions.

Not everyone can become an entrepreneur. Why is that? Will you be able to start your own business with no outside help after you graduate?

1. One of the requirements for success as an entrepreneur is
   a. access to funds to start the business
   b. choosing a low-risk business to enter
   c. beginner’s luck
   d. a college education
   e. an aversion to risk taking

Consider what type of goods is usually purchased with fixed-cost expenditures.

2. Committing to fixed costs often means that an entrepreneur must
   a. produce services instead of goods
   b. study the history of costs
   c. borrow to finance the purchase of plant and machinery
   d. vary expenditures on fixed costs as output varies
   e. cut these costs when output is low

In answering the following question, remember that average total costs equal the sum of average variable costs and average fixed costs.

3. As output increases, average total cost and average variable cost approach the same value because
   a. average fixed costs are always quite low
   b. total costs don’t include fixed costs
   c. fixed costs are sunk costs
   d. marginal cost is less than average total cost
   e. average fixed costs decrease as output increases

The next question is related to the reason for the upturn in long-run average costs at high levels of output.

4. Diseconomies of scale result from
   a. economies of scale
   b. constant returns to scale
   c. problems with technology
   d. problems managing a large firm
   e. higher fixed costs

If the marginal value is less than the average, then what happens to the average?

5. Average total cost decreases as long as marginal cost is
   a. zero
   b. less than average total cost
   c. less than average fixed cost
   d. rising
   e. greater than average variable cost
Am I on the Right Track?

Your answers to the questions above should be a, c, e, d, and b. One critical aspect of this chapter is to relate the calculation of costs to the way they are graphed. After you work through the Key Terms Quiz, a graphing tutorial is presented that walks you through the calculation of average costs and marginal costs and carefully considers how the graphs for the average cost concepts are drawn.

Key Terms Quiz — Match the terms on the left with the definitions in the column on the right.

1. total fixed costs _____ a. the addition to total cost from producing one more unit
2. total variable costs _____ b. output per laborer per hour
3. law of diminishing returns _____ c. decreases in average cost that accompany increases in scale of output
4. labor productivity _____ d. addition to output from each additional worker diminishes
5. quality of labor _____ e. time enough to change only some of the resources for production
6. total costs _____ f. total fixed cost divided by the quantity produced
7. average total cost _____ g. costs per unit of output that are constant as the scale of production increases
8. average fixed cost _____ h. time enough to change all of the resources for production
9. average variable cost _____ i. adjusting plant size to produce in the most efficient manner
10. marginal cost _____ j. average fixed cost plus average variable cost
11. economies of scale _____ k. total fixed costs plus total variable costs
12. diseconomies of scale _____ l. costs that vary with the level of production
13. constant returns to scale _____ m. differences between workers in ability and experience
14. short run _____ n. decreasing plant size to produce in the most efficient manner
15. long run _____ o. increasing average total costs due to management problems as the scale of production increases
     _____ p. contracting out part or parts of a production process to external sources
16. rightsizing _____ q. costs that don’t change with the level of production
17. downsizing _____ n. total variable cost divided by the quantity produced
18. outsourcing

Graphing Tutorial

There are quite a few new graphs to learn in this chapter. In this section, we’ll focus on the average total cost, average variable cost, average fixed cost, and marginal cost curves. These curves are frequently drawn together, and they are very important for work you will do in the next several chapters. A picture of a firm’s average cost and marginal cost curves can be combined with price information to find out whether the firm will be profitable or not. Certainly, this is an important issue. We’ll address the problem of maximizing profit in the next chapter. Right now, our goal is to understand the nature of a firm’s costs of production and how to properly represent them in a graph.

Consider the following data for the Merkle Broom Company in Paris, Illinois. The table on the next page shows the monthly output of brooms, total fixed costs, total variable costs, and total costs for the broom company. The first column shows monthly broom output measured in thousands. The second column shows the total fixed costs of producing from 0 to 10,000 brooms per month. Notice that it is fixed at $15,000. This fixed expenditure corresponds to the fixed cost of the factory. If the owners of Merkle Broom Company took out a loan to build their factory and the monthly payment on the loan is $15,000, then these are its fixed costs. Look at the third column in the table. This column shows the total variable costs of producing different quantities of brooms. The variable costs vary with the quantity of brooms produced. Variable costs correspond to labor costs and the costs of the raw materials that go into the manufacture of brooms — broom corn, twine
for binding, and wooden handles, in addition to paint, dyes, and packaging materials. To produce more brooms requires more of all of these inputs. Of these inputs, labor is the most important. Look at how total variable costs change as output increases. At first, total variable costs rise at a decreasing rate up to an output level of 4,000 brooms. Then, total variable costs rise at an increasing rate. Beyond 4,000 brooms, each additional 1,000 brooms produced costs more than the previous 1,000 brooms. This is due to the law of diminishing returns. As more workers are added to production, each one adds less to total product than did the one before. Therefore, proportionately more labor must be hired to get the same 1,000-broom increase; hence, total variable costs begin to increase at an increasing rate. The fourth column shows the total costs of producing these different quantities of brooms. If you were to graph total variable cost and total cost, the two curves would lie parallel to each other with the vertical distance between them equal to total fixed cost.

<table>
<thead>
<tr>
<th>Quantity of Brooms (1,000s)</th>
<th>Total Fixed Costs ($1,000s)</th>
<th>Total Variable Costs ($1,000s)</th>
<th>Total Costs ($1,000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>22</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>24</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td>39</td>
<td>54</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>54</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>15</td>
<td>72</td>
<td>87</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>94</td>
<td>109</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>122</td>
<td>137</td>
</tr>
</tbody>
</table>

Suppose that Oscar Merkle, the owner of Merkle Brooms, wants to know the average costs of production. This is clearly an important piece of information. By comparing the average cost of a broom with its price, Oscar will know whether he is making or losing money on each broom produced. Average costs can be computed from the data presented in the table above. For example, average fixed cost is equal to total fixed cost divided by quantity. This quotient gives you the fixed cost per broom. Similarly, average variable cost is equal to total variable cost divided by quantity, and average total cost is equal to total cost divided by quantity. A table showing the average costs of production for the various output levels is shown on the following page. One other variable is included in the last column of the table — marginal cost. Marginal cost is the change in total cost divided by the change in output. You could also calculate the marginal cost from the total variable cost by dividing the change in total variable cost by the change in output. Do you see why these two computations give the same result? The only difference between total cost and total variable cost is total fixed cost. So, our calculations show that the marginal cost per broom of the first 1,000 brooms is $12,000/1,000 or $12. For the second 1,000 brooms we have $6,000/1,000 or $6. Make sure you understand where all these numbers came from.
<table>
<thead>
<tr>
<th>Quantity of Brooms (1,000s)</th>
<th>Average Fixed Cost ($/broom)</th>
<th>Average Variable Cost ($/broom)</th>
<th>Average Total Cost ($/broom)</th>
<th>Marginal Cost ($/broom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15.00</td>
<td>12.00</td>
<td>27.00</td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>7.50</td>
<td>9.00</td>
<td>16.50</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>5.00</td>
<td>7.33</td>
<td>12.33</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3.75</td>
<td>6.00</td>
<td>9.75</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>3.00</td>
<td>6.00</td>
<td>9.00</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>2.50</td>
<td>6.50</td>
<td>9.00</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>2.14</td>
<td>7.70</td>
<td>9.86</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>1.88</td>
<td>9.00</td>
<td>10.88</td>
<td>18</td>
</tr>
<tr>
<td>8</td>
<td>1.67</td>
<td>10.44</td>
<td>12.11</td>
<td>22</td>
</tr>
<tr>
<td>9</td>
<td>1.50</td>
<td>12.20</td>
<td>13.70</td>
<td>28</td>
</tr>
</tbody>
</table>

Now that we have our data organized, we can proceed with graphing the average cost and marginal cost curves. As usual, we plot the quantity on the horizontal axis and the cost values, measured in dollars per broom, vertically. A graph of these curves is shown below.

The marginal cost, average total cost, average variable cost, and average fixed cost curves are labeled MC, ATC, AVC, and AFC, respectively. Note that the ATC, AVC, and MC all have characteristic U-shapes. The ATC and AVC approach each other as output increases because the difference between them is the AFC, which gets smaller as output increases. The MC intersects the AVC and the ATC at their minimums. When MC is less than AVC or ATC, the average costs must fall because a marginal cost that is less than the average is added to the total cost. You see, don’t you? The smaller marginal cost value pulls the average costs down. Similarly, when MC is greater than AVC or ATC, the average costs must rise because a marginal cost that is greater than the average is added to total cost. The larger marginal cost value pulls the average costs up.
You will encounter this kind of picture for a firm’s average and marginal costs often from this chapter onward. The exercises below give you a chance to practice interpreting and drawing average and marginal costs.

**Graphing Pitfalls**

Consider the average total cost and marginal cost curves shown below. What’s wrong with them? These curves aren’t drawn correctly. Marginal cost always intersects average total cost at its minimum.

This graph is incorrect because the marginal cost curve doesn’t intersect the average total cost curve at its minimum point.

**True-False Questions** — If a statement is false, explain why.

1. More people would probably become entrepreneurs if start-up capital were more readily available. (T/F)

2. Entrepreneurs rarely, if ever, have much experience in the businesses they enter. (T/F)

3. The short run refers to a time period of one year or less. (T/F)

4. Fixed costs rise as the level of output rises. (T/F)

5. In general, a larger outlay for fixed cost assets provides a firm with greater productive capacity. (T/F)
6. Total variable cost is unaffected by the law of diminishing returns. (T/F)

7. Labor is typically the most significant component of total variable costs. (T/F)

8. Labor productivity increases continuously as the size of the labor force is increased. (T/F)

9. Beyond some point in production, total variable cost increases at an increasing rate. (T/F)

10. Average total cost is equal to total cost divided by quantity. (T/F)

11. For the law of diminishing returns to apply, at least one factor of production must be held constant. (T/F)

12. Whenever marginal cost is less than average total cost, average total cost must be decreasing. (T/F)

13. A firm can avoid encountering diseconomies of scale in production by continuously increasing the number of its manufacturing plants. (T/F)

14. If an increase in the scale of a firm’s operations causes a decrease in the average total cost, then the firm is said to benefit from economies of scale. (T/F)

15. Diseconomies of scale are caused by increases in the cost of certain resources critical to a production process that occur when production levels are very high. (T/F)

Multiple-Choice Questions

1. Entrepreneurship is attractive to those who practice it because
   a. it is a chance to make high profit without having financial or technical expertise
   b. it provides an alternative to working for someone else
   c. it is based mainly on luck or chance
   d. it means never having to face unemployment
   e. unlike others forms of activity, very few actually lose money

2. If a firm is operating in the short run, then
   a. some of the resources used in production are fixed
   b. all resources used in production are fixed
   c. increases in output can be achieved only by increasing the use of one resource
   d. there is ample time to alter both the amount of labor and the amount of capital employed
   e. all resources used in production can be changed
3. By purchasing a larger fixed-cost item, like the maxiboat discussed in the text, an entrepreneur incurs higher start-up costs but benefits from
   a. greater freedom from risk
   b. lower operating costs
   c. greater fixed-cost flexibility
   d. paying off larger debt at lower rates of interest
   e. greater production capacity

4. Labor productivity refers to the
   a. work ethic of the firm's laborers
   b. willingness of workers to work overtime until a job is done
   c. output per laborer per hour
   d. quality of work a laborer does
   e. human capital associated with a particular labor skill

5. The reason that the total variable cost curve eventually begins to increase at an increasing rate as output increases is
   a. the law of diminishing returns
   b. new opportunities for specialization and division of labor
   c. the law of diminishing returns
   d. marginal cost is greater than average total cost
   e. diseconomies of scale

6. Some cost items are referred to as variable cost items because
   a. they vary from firm to firm in an industry
   b. they vary from industry to industry
   c. they vary from country to country
   d. their costs vary depending on the level of production
   e. their costs vary over time

7. Labor is a variable cost item whose costs will usually rise with production levels at a(n) ______ rate at first but then rise at a(n) ______ rate because of changes in labor productivity, quality, and price.
   a. decreasing; increasing
   b. increasing; decreasing
   c. constant; decreasing
   d. constant; increasing
   e. increasing; constant

8. The graph shown on the next page depicts total variable costs such that beyond an output level of 10,000
   a. output increases at an increasing rate
   b. total variable cost rises at an increasing rate
   c. total variable cost rises at a constant rate
   d. total variable cost is constant
   e. the firm should cut back
9. Because total cost is the sum of total fixed cost and total variable cost, the total cost curve has the same
shape as the ________ curve but is shifted ________ by the amount of total fixed costs.
   a. average cost; up
   b. total fixed cost; up
   c. total fixed cost; down
   d. total variable cost; down
   e. total variable cost; up

10. Imagine a situation where the firm’s total fixed cost is zero. In this case, the firm’s
    a. MC curve is a straight line
    b. TC curve is a straight line
    c. TVC curve is a straight line
    d. ATC = AVC
    e. MC = ATC

11. Marginal cost and total cost are related such that
    a. marginal cost is the change in total cost resulting from a change in the quantity produced
    b. marginal cost is total cost divided by the level of output
    c. marginal cost is greater than total cost at any level of output
    d. marginal cost is decreasing when the total cost curve’s slope becomes very steep
    e. marginal cost is always greater than total cost

12. Marginal cost and average total cost are related such that
    a. when marginal cost is decreasing, average total cost is increasing
    b. when marginal cost is at a minimum, so is average total cost
    c. when average total cost is at a minimum, marginal cost and average total cost are equal
    d. when marginal cost is at a minimum, marginal cost and average total cost are equal
    e. marginal cost is always less than average total cost
13. Average total cost is defined as ________ while marginal cost is defined as ________.
   a. the change in total cost divided by the change in quantity; total cost divided by quantity
   b. total cost divided by quantity; the change in total cost divided by the change in quantity
   c. the change in quantity divided by the change in total cost; quantity divided by total cost
   d. quantity divided by total cost; the change in quantity divided by the change in total cost
   e. average variable cost minus average fixed cost; any small addition to costs

14. Diseconomies of scale result when
   a. diminishing returns become apparent
   b. a particular input becomes more expensive at high levels of output
   c. technology fails to improve
   d. average total costs increase at high levels of output due to inefficiencies in management
   e. further growth for the firm is impossible

15. The shape of the total fixed cost curve is
   a. horizontal
   b. U-shaped
   c. downward-sloping
   d. upward-sloping
   e. vertical

16. Suppose that you are the manager of a factory producing compact discs. You observe that for the first ten workers hired, each one adds increasing amounts to total product, but starting with the eleventh worker, they each add smaller and smaller amounts to total product. You are observing
   a. the law of increasing cost
   b. diseconomies of scale
   c. the average total cost curve
   d. the law of diminishing returns
   e. the law of diminishing total product

17. If a firm doubles its inputs, doubles its total costs, and output more than doubles, then we can be sure that the firm is experiencing
   a. the law of diminishing returns
   b. diseconomies of scale
   c. rising marginal costs
   d. economies of scale
   e. constant returns to scale

18. The text says "behind every cost curve is a socioeconomic structure." This means that
   a. social status often dictates which entrepreneurs succeed and which fail
   b. the ability to produce efficiently depends, to a large extent, on human relations
   c. firms count on government as well as social institutions and habits to control cost
   d. the availability of social institutions, such as schools and hospitals, is a prerequisite to modern production
   e. every material cost, whether fixed or variable, has an unintended effect on social relations
19. When a firm engages in downsizing along its long-run ATC, it typically
   a. increases its productive capacity to reduce its short-run ATC
   b. reduces its productive capacity to reduce its short-run ATC
   c. increases its productive capacity to capture economies of scale
   d. decreases its productive capacity to capture diseconomies of scale
   e. lowers its long-run ATC curve to reduce its short-run ATC

20. Most business managers _______ with the economists’ conception of the U-shaped average total cost
   curve because _______.
   a. agree; their own cost curves are U-shaped
   b. agree; they believe other firms have U-shaped cost curves, even if they don't
   c. disagree; they rarely produce in the range where average total costs are rising
   d. disagree; they rarely produce in the range where average total costs are falling
   e. disagree; they know no two firms are alike so that average total cost could be, or not be, U-shaped

The following questions relate to the theoretical, applied, and global perspectives in the text.

21. Advances in the technology of printing that were introduced by the publishing house Ticknor and Fields on
   publication of Nathaniel Hawthorne’s, The Scarlet Letter, allowed the book to be
   a. published as a part of a much longer work that was a collection of stories
   b. the best-selling book in American literary history
   c. printed in a more modern and attractive font
   d. produced in larger quantities and in less time so as to reach a broader audience
   e. widely read due to its uniquely modern appearance in spite of its controversial themes

22. The costs associated with an entrepreneur’s time and resources that are devoted to production in a firm are
   a. excluded from the calculation of average total cost since only explicit costs are considered
   b. excluded from the calculation of average total cost since they are not opportunity costs
   c. included in the calculation of average total cost since opportunity costs include implicit costs
   d. included in the calculation of average total cost because they are explicit monetary costs
   e. excluded from the calculation of average total cost because they are difficult to measure accurately

23. An important way that firms are able to experience economies of scale, like those observed on the fishing
   trawler the Alaska Ocean, is through
   a. solving the problem of managing a very large firm
   b. replacing labor with capital, i.e., new machines that mechanize fish processing
   c. hiring better quality labor
   d. on-the-job training for newly hired workers on the trawler
   e. the existence of numerous opportunities for specialization and division of labor

24. An important advantage associated with outsourcing production of components for a computer is that
   a. outsourcing prevents diseconomies of scale
   b. countries other than the United States have workers who are more technically-trained
   c. outsourcing permits firms to take advantage of specialization and division of labor on a global scale
   d. outsourcing prevents firms from experiencing diminishing returns
   e. because computers are so complex, few jobs in the U.S. computer industry are lost to LDCs

Fill in the Blanks

1. An example of a ________________ is a monthly payment that a business must make regardless of the
   level of production.
2. The cost of labor increases at a(n) ________________ rate at a low level of output and at a(n)
______________ rate at higher levels of output for three reasons.

3. The reasons for the behavior of the cost of labor just described are ____________________,
__________________, and ____________________.

4. As output increases, the average _____________ cost approaches the average ________________ cost
because the average _______________ cost decreases.

5. In the ________________, at least one factor of production is fixed, but in the ________________, all
factors of production can be varied.

Discussion Questions

1. Why do some people decide to become entrepreneurs, and why do others choose to work for a wage or a
salary?

2. What is the difference between fixed and variable costs? Explain the shape of the total variable cost curve
and explain why the vertical distance between the total cost and total variable cost curves is constant.

3. How does a firm such as the Merkle Broom Company described in the graphing tutorial use its average
total cost curve to find out if a given price will result in a profit or a loss? What is the lowest price that the
Merkle Broom Company could sell brooms for and still avoid a loss? Explain.

4. What is the difference between marginal cost and average total cost?

5. Discuss the factors that give rise to economies of scale and diseconomies of scale.
Problems

1. Suppose that you are the owner of a new microbrewery in a midwestern college town. The table below shows your total costs of production per month.

<table>
<thead>
<tr>
<th>Quantity of Beer (cases per month)</th>
<th>Total Fixed Cost ($)</th>
<th>Total Variable Cost ($)</th>
<th>Total Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,000</td>
<td>0</td>
<td>1,000</td>
</tr>
<tr>
<td>100</td>
<td>1,000</td>
<td>600</td>
<td>1,600</td>
</tr>
<tr>
<td>200</td>
<td>1,000</td>
<td>1,000</td>
<td>2,000</td>
</tr>
<tr>
<td>300</td>
<td>1,000</td>
<td>1,300</td>
<td>2,300</td>
</tr>
<tr>
<td>400</td>
<td>1,000</td>
<td>2,200</td>
<td>3,200</td>
</tr>
<tr>
<td>500</td>
<td>1,000</td>
<td>3,300</td>
<td>4,300</td>
</tr>
<tr>
<td>600</td>
<td>1,000</td>
<td>4,800</td>
<td>5,800</td>
</tr>
</tbody>
</table>

a. On the axes provided below, sketch the total fixed cost, total variable cost, and total cost curves.

b. How are the total variable cost and total cost curves positioned relative to one another in your sketch? What accounts for this positioning?
c. Does the total variable cost curve have the shape that you would expect from the discussion presented in the text? What accounts for this shape?

2. a. Using the information presented in problem 1, fill in the following table.

<table>
<thead>
<tr>
<th>Quantity of Beer (cases per month)</th>
<th>Average Fixed Cost ($/case)</th>
<th>Average Variable Cost ($/case)</th>
<th>Average Total Cost ($/case)</th>
<th>Marginal Cost ($/case)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. On the axes provided below, graph the information you calculated in the table above.

c. Suppose the price of a case of beer is $10. What is the minimum number of cases per month that you could produce and sell and still cover your costs of production? How do you know?
3. Suppose there’s a firm that manufactures umbrellas called the Rain All You Want But I Don’t Get Wet Company. The table on the following page displays some of its cost structure.

<table>
<thead>
<tr>
<th>Quantity of Umbrellas</th>
<th>TFC</th>
<th>TVC</th>
<th>TC</th>
<th>MC</th>
<th>ATC</th>
<th>AVC</th>
<th>AFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>24</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. What is the total fixed cost of producing 2 umbrellas? How do you know?

b. What is the marginal cost of the sixth umbrella? How do you know?

c. Calculate the average fixed cost of the fifth unit. Show your work.

d. Calculate the total variable cost and the average variable cost of producing 8 units. Show your work.

**Everyday Applications**

Nearly everyone has had the opportunity to be part of a fund-raising effort for an organization. Fund raising is hard work, and costly too. Consider your own experience with the business of collecting cash donations. Did the process involve fixed and variable costs? Was there a marginal cost associated with generating additional dollar donations? How did the revenues generated compare to the costs?

**Economics Online**

Costs of production figure importantly in the work of engineers. Cost engineers are concerned with combining fixed and variable cost resources to produce output. Often, the goal is to achieve a certain level of output at minimum cost. The Association for the Advancement of Cost Engineering through Total Cost Management has a site (http://www.aacei.org/). Do you notice differences in the way economists and engineers view costs of production?

**Answers to Questions**

**Key Terms Quiz**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 10</td>
<td>f. 8</td>
<td>k. 6</td>
<td>p. 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. 4</td>
<td>g. 13</td>
<td>l. 2</td>
<td>q. 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. 11</td>
<td>h. 15</td>
<td>m. 5</td>
<td>n. 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. 3</td>
<td>i. 16</td>
<td>n. 17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. 14</td>
<td>j. 7</td>
<td>o. 12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
True-False Questions

1. True
2. False. Entrepreneurs typically have some background in the businesses they enter.
3. False. The short run is the period of time in which a producer can vary some, but not all, of the resources used in production.
4. False. Fixed costs don’t change with the level of output.
5. True
6. False. Total variable cost rises at an increasing rate because of diminishing returns.
7. True
8. False. Labor productivity might fall due to the law of diminishing returns and hiring workers with less experience and ability.
9. True
10. True
11. True
12. True
13. False. Diseconomies of scale mean that the firm’s long-run average total cost increases. By cutting back on the size of the operation and streamlining complex managerial and bureaucratic hierarchies, the firm can decrease long-run average total cost.
14. True
15. False. Diseconomies of scale stem from problems associated with managing a very large firm.

Multiple-Choice Questions

2. a  7. a  12. c  17. d  22. c
3. e  8. b  13. b  18. d  23. e
5. a  10. d  15. a  20. c

Fill in the Blanks

1. fixed cost
2. decreasing; increasing
3. labor productivity; labor quality; labor cost
4. variable; total; fixed
5. short run; long run

Discussion Questions

1. Some people prefer not to be employed by others. They may have strong leadership qualities that are suited for running a business firm. Entrepreneurs usually have a good working knowledge of the business that they are entering. They may have been employed in the industry for a time and then decided to found a new business. A willingness to take risks is a common characteristic among entrepreneurs.

2. Fixed costs are constant as output increases. The firm must pay its fixed costs whether it produces or not. Fixed costs are associated with the firm’s plant and capital. Frequently, money is borrowed to start a firm, and the regular payments that must be made for these debts represent fixed costs. Variable costs increase with the level of output. Variable costs include the cost of labor and raw materials that go into production. In lower ranges of output, total variable costs increase at a decreasing rate. The total variable cost curve becomes flatter. Each worker adds more to output than to variable costs in this range. However, at some point as output increases, the total variable cost curve begins to rise at an increasing rate. Each worker adds less to total output than the one before. The law of diminishing returns is apparent in this range.
3. A firm can compare the price of its output with the average total cost at that output to figure its profit or loss. If the price is above the average total cost, the firm makes a profit. If it is below, the firm suffers a loss. The lowest price that Merkle Broom could receive and not face a loss is $9.00 at an output level of 6,000 brooms.

4. Marginal cost is the addition to total cost from producing one more unit of a good. It can also be expressed as the change in total cost divided by the change in quantity. Average total cost is total cost divided by output. Average total cost is computed at a specific level of output. Marginal cost is computed between two levels of output.

5. Economies of scale are marked by decreasing average total costs of production that occur as a result of an increase in the scale of a firm’s operation that happens over the long run. The firm is able to vary the levels of all resources used in production. As the scale of production increases, by adding new plant, capital, and technology in addition to more laborers, the firm can take advantage of new opportunities for specialization and division of labor. Labor productivity rises as a result. Diseconomies of scale arise from the problems associated with managing a very large firm. Bureaucracies become entrenched. Managerial responsibilities become confused. Communication is unclear within the firm. Inefficiencies are the result with rising average costs of production in the long run. The long-run average cost curve begins to turn up, and if the firm wants to lower its average costs, it must downsize.

Problems

1. a. The graph you sketch should look like the one shown below.

   ![Graph](image)

   b. The vertical distance between total cost and total variable cost is total fixed cost which is constant.

   c. The shapes of both the total variable cost curve and the total cost curve are similar to the shapes encountered in the text. It is primarily the nature of labor's contribution to costs that accounts for the shape of these curves. At lower levels of output, each additional worker adds more to total output than to costs. Therefore, total variable and total costs rise at a decreasing rate. However, as output increases, the contribution from each additional worker to output begins to diminish — diminishing returns set in — output rises more slowly than costs, so the total variable and total costs begin to rise at an increasing rate.

2. a. The values in your table should correspond to those shown on the following page.
<table>
<thead>
<tr>
<th>Quantity of Beer (cases per month)</th>
<th>Average Fixed Cost ($/case)</th>
<th>Average Variable Cost ($/case)</th>
<th>Average Total Cost ($/case)</th>
<th>Marginal Cost ($/case)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>6</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>300</td>
<td>3.33</td>
<td>4.33</td>
<td>7.67</td>
<td>4</td>
</tr>
<tr>
<td>400</td>
<td>2.5</td>
<td>5.5</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>500</td>
<td>2</td>
<td>6.6</td>
<td>8.6</td>
<td>11</td>
</tr>
<tr>
<td>600</td>
<td>1.67</td>
<td>8</td>
<td>9.67</td>
<td>15</td>
</tr>
</tbody>
</table>

b. Your graph should look like the one shown below.

![Graph showing Average and Marginal Costs](image)

c. Your microbrewery would have to sell at least 200 cases of beer per month because the average total cost of producing 200 cases is $10 per case. The price would just cover the average total cost of a case of beer.

3. a. The total fixed cost is the difference between the total cost and the total variable cost at any level of output. Therefore, it is equal to 34 – 24 or 10.

b. The marginal cost of the sixth umbrella is the change in total cost divided by the change in quantity, or 38 – 24 divided by 1 or 14. Marginal cost can be computed from either the total variable cost series or the total cost series. Marginal costs have to be variable costs because they correspond to costs that vary with output.

c. The average fixed cost of the fifth unit is 10 divided by 5 or 2. Total fixed cost is 10. Average fixed cost is total fixed cost divided by the quantity, which was 5 in this case.

d. The total variable cost of producing 8 units is 98 – 10 or 88. The average variable cost of producing 8 units is 88 divided by 8 or 11.
Homework Questions

True-False Questions — If a statement is false, explain why.

1. When marginal cost is less than average total cost, average total cost must be increasing. (T/F)

2. Economies of scale are reflected by a long-run average total cost curve that is rising. (T/F)

3. Average total cost and average variable cost both decrease continuously as the quantity produced increases. (T/F)

4. The cost of capital goods is usually a fixed cost for firms. (T/F)

5. Marginal cost is the addition to total cost from producing one more unit of a good, whereas average total cost is equal to total cost divided by the number of units produced. (T/F)

Multiple-Choice Questions

1. The difference between the short run and the long run is that
   a. the short run is less than one year while the long run is one year or more
   b. at least one resource used in production is fixed in the short run whereas no resources are fixed in the long run
   c. diminishing returns are a long-run problem and diseconomies of scale are a short-run problem
   d. economies of scale are evident in the short run while constant returns to scale are evident in the long run
   e. the firm must cover its fixed costs in the short run and its variable costs in the long run

2. Average fixed cost decreases as output increases because
   a. total fixed cost is constant
   b. marginal cost is less than average total cost
   c. marginal cost is greater than average total cost
   d. average variable cost is less than average fixed cost
   e. average variable cost is greater than average fixed cost

3. A firm that experiences diseconomies of scale should
   a. add greater capacity by building new plants and adding workers
   b. downsize
   c. hire a management consultant
   d. be certain that marginal cost is always less than average total cost
   e. focus on research and development of new technologies

4. The total variable cost curve and the total cost curve increase at an increasing rate when
   a. marginal cost is decreasing
   b. average variable and average total costs are decreasing
   c. they are greater than total fixed cost
   d. the law of diminishing returns applies
   e. diseconomies of scale are notable
5. Suppose that at an output level of 200 units the average total cost is $1.00 per unit and the average variable cost is $.60 per unit. We know that the
   a. total variable cost is $600
   b. total cost is $300
   c. average fixed cost is $.30 per unit
   d. total fixed cost is $80
   e. marginal cost is less than average total cost

**Discussion Questions/Problems**

1. Using a graph and in words, explain what is meant by economies of scale, constant returns to scale, and diseconomies of scale.

2. Suppose that the total cost of producing 20 belts is $100 and the total variable cost of producing 20 belts is $60. Compute average total cost, average variable cost, and average fixed cost. Show your work.